

Claims:

1. A filter adaptation unit suitable for producing a set of filter coefficients indicative of a transfer function of a system in a given state, said filter adaptation unit comprising:

5 a) a first input for receiving a sequence of samples of a first signal;

b) a second input for receiving a sequence of samples of a second signal, the second signal including a certain component which is correlated to the first signal;

c) a coefficient generation unit operatively coupled to said first input and said second input, said coefficient generation unit being operative for generating:

10 i. a first set of filter coefficients on the basis of first subsets of the sequences of samples of the first signal and the second signal, the first set of filter coefficients being such that when the first set of filter coefficients is applied by an adaptive filter on the first signal, a first estimate of the certain component in the second signal is generated, the certain component being correlated to the first signal;

15 ii. a second set of filter coefficients on the basis of second subsets of the sequences of samples of the first signal and the second signal, at least some samples in the second subsets being subsequent to the samples in corresponding first subsets, the second set of filter coefficients being such that when the first set of filter coefficients is applied by an adaptive filter on the first signal, a second estimate of the certain component in the second signal is generated, the certain component being correlated to the first signal;

d) an error characterization unit operative for:

20 i. processing the first signal and the second signal on the basis of the first set of filter coefficients to generate a first set of error characterization data elements associated to the first set of filter coefficients;

ii. processing the first signal and the second signal on the basis of the second set of filter coefficients to generate a second set of error characterization data elements associated to the second set of filter coefficients;

25 e) a selection unit operative for:

i. detecting a change of state at least in part of the basis of:

(a) the first and second sets of filter coefficients; and

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(b) the second set of error characterization data elements;

ii. selecting the second set of filter coefficients when a change of state is detected in i.;

iii. selecting either one of the first set of filter coefficients and the second set of filter coefficients, at least in part, on the basis of the first and second sets of error characterization data elements when no change of state is detected in i.;

f) an output for releasing a signal indicative of the set of filter coefficients selected by the selection unit.

10 2. A filter adaptation unit as defined in claim 1, wherein:

a) the first subset of the sequence of samples of the first signal includes a plurality of successive samples, said plurality of successive samples including a beginning sample;

b) the second subset of the sequence of samples of the first signal includes a plurality of successive samples, said plurality of successive samples including a beginning sample;

c) said selection unit operative for precluding detection of a change of state when the beginning sample of the first subset of the sequence of samples of the first signal is received by the first input of the filter adaptation unit subsequent to the beginning sample of second subset of the sequence of samples of the first signal .

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3. A filter adaptation unit as defined in claim 2, wherein said selection unit is operative for:

a) comparing the first set of filter coefficients and the second set of filter coefficients to derive a first distance measure data element;

b) comparing the first set of error characterization data elements and the second set of error characterization data elements to derive a second distance measure data element;

c) detecting a change of state at least in part of the basis of the first distance measure data element and the second distance measure data element.

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4. A filter adaptation unit as defined in claim 3, wherein each error characterization data element in the first and second sets of error characterization data elements is associated to a respective frequency band selected from a set of frequency bands, said selection unit being operative for:

5 a) processing the first set of filter coefficients to derive a first set of spectral values, each spectral value in said first set corresponding to a respective frequency band selected from a set of frequency bands;

10 b) processing the second set of filter coefficients to derive a second set of spectral values, each spectral value in said second set corresponding to a respective frequency band selected from a set of frequency bands;

c) comparing the first set of spectral values to the second set of spectral values to derive a set of first distance measure data elements, each of said first distance measure data elements being associated to a respective frequency band from the set of frequency bands;

15 d) comparing the first set of error characterization data elements and the second set of error characterization data elements to derive a set of second distance measure data element, each of said second distance measure data elements being associated to a respective frequency band from the set of frequency bands;

e) detecting a change of state at least in part on the basis of the set of first distance
20 measure data elements and the set of second distance measure data elements.

5. A filter adaptation unit as defined in claim 1, wherein each error characterization data element in the first and second sets of error characterization data elements is associated to a respective frequency band selected from a set of frequency bands.

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6. A filter adaptation unit as defined in claim 5, wherein each error characterization data element in the first and second sets of error characterization data elements includes a standard deviation data element associated to a respective frequency band in the set of frequency bands.

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7. A filter adaptation unit as defined in claim 6, wherein said selection unit is operative for:

- a) computing a first energy data element at least in part on the basis of the first set of error characterization data elements, the first energy data element being indicative of an error size associated to the first set of filter coefficients;
- b) computing a second energy data element at least in part on the basis of the second set of error characterization data elements, the second energy data element being indicative of an error size associated to the second set of filter coefficients;
- c) selecting the set of filter coefficients on the basis of the first energy data element and the second energy data element when no change of state is detected.

10 8. A filter adaptation unit as defined in claim 1, wherein said selection unit is operative for processing the selected set of filter coefficients at least in part on the basis of a reference set of data elements prior to release at the output to determine whether the selected set of filter coefficients is indicative of a substantially null transfer function.

15 9. A filter adaptation unit as defined in claim 8, wherein when the selected set of filter coefficients is indicative of a substantially null transfer function, said selection unit being operative for replacing the selected set of filter coefficients by a null set of filter coefficients prior to releasing the selected set of filter coefficients at the output.

20 10. A method suitable for producing a set of filter coefficients indicative of a transfer function of a system in a given state, said method comprising:

- a) receiving a sequence of samples of a first signal;
- b) receiving a sequence of samples of a second signal, the second signal including a certain component which is correlated to the first signal;
- c) generating a first set of filter coefficients on the basis of first subsets of the sequences of samples of the first signal and the second signal, the first set of filter coefficients being such that when the first set of filter coefficients is applied by an adaptive filter on the first signal, a first estimate of the certain component in the second signal is generated, the certain component being correlated to the first signal;
- d) generating a second set of filter coefficients on the basis of second subsets of the sequences of samples of the first signal and the second signal, at least some

samples in the second subsets being subsequent to the samples in corresponding first subsets, the second set of filter coefficients being such that when the second set of filter coefficients is applied by an adaptive filter on the first signal, a second estimate of the certain component in the second signal is generated, the certain component being correlated to the first signal;

10 e) processing the first signal and the second signal on the basis of the first set of filter coefficients to generate a first set of error characterization data elements associated to the first set of filter coefficients;

f) processing the first signal and the second signal on the basis of the second set of filter coefficients to generate a second set of error characterization data elements associated to the second set of filter coefficients;

15 g) detecting a change of state at least in part of the basis of:

- i. the first and second sets of filter coefficients; and
- ii. the second set of error characterization data elements;

h) selecting the second set of filter coefficients when a change of state is detected in g);

i) selecting either one of the first set of filter coefficients and the second set of filter coefficients at least in part on the basis of the first and second sets of error characterization data elements when no change of state is detected in g);

20 j) releasing a signal indicative of the selected set of filter coefficients.

11. A method as defined in claim 10, wherein:

25 a) the first subset of the sequence of samples of the first signal includes a plurality
 of successive samples, said plurality of successive samples including a beginning
 sample;

 b) the second subset of the sequence of samples of the first signal includes a plurality
 of successive samples, said plurality of successive samples including a beginning sample;

30 said method further comprising precluding detection of a change of state when the
 beginning sample of the first subset of the sequence of samples of the first signal is
 received subsequently to the beginning sample of the second subset of the sequence of
 samples of the first signal.

12. A method as defined in claim 11, wherein said method further comprises:

- a) comparing the first set of filter coefficients and the second set of filter coefficients to derive a first distance measure data element;
- 5 b) comparing the first set of error characterization data elements and the second set of error characterization data elements to derive a second distance measure data element;
- c) detecting a change of state at least in part on the basis of the first distance measure data element and the second distance measure data element.

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13. A method as defined in claim 12, wherein each error characterization data element in the first and second sets of error characterization data elements is associated to a respective frequency band selected from a set of frequency bands, said method further comprising:

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- a) processing the first set of filter coefficients to derive a first set of spectral values, each spectral value in said first set corresponding to a respective frequency band selected from a set of frequency bands;

- b) processing the second set of filter coefficients to derive a second set of spectral values, each spectral value in said second set corresponding to a respective frequency band selected from a set of frequency bands;

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- c) comparing the first set of spectral values to the second set of spectral values to derive a set of first distance measure data elements, each of said first distance measure data elements being associated to a respective frequency band from the set of frequency bands;

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- d) comparing the first set of error characterization data elements and the second set of error characterization data elements to derive a set of second distance measure data element, each of said second distance measure data elements being associated to a respective frequency band from the set of frequency bands;

- e) detecting a change of state, at least in part, on the basis of the set of first distance measure data elements and the set of second distance measure data elements.

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14. A method as defined in claim 10, wherein each error characterization data element in the first set of error characterization data elements and in the second set of error characterization data elements is associated to a respective frequency band selected from a set of frequency bands.

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15. A method as defined in claim 14, wherein each error characterization data element in the first and second sets of error characterization data elements includes a standard deviation data element associated to a respective frequency band in the set of frequency bands.

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16. A method as defined in claim 15, wherein said method comprises:

- a) computing a first energy data element at least in part on the basis of the first set of error characterization data elements, the first energy data element being indicative of an error size associated to the first set of filter coefficients;
- b) computing a second energy data element at least in part on the basis of the second set of error characterization data elements, the second energy data element being indicative of an error size associated to the second set of filter coefficients;
- c) selecting the set of filter coefficients on the basis of the first energy data element and the second energy data element when no change of state is detected.

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20 17. A method as defined in claim 10, wherein said method comprises processing the selected set of filter coefficients at least in part on the basis of a reference set of data elements prior to releasing the selected set of filter coefficients to determine whether the selected set of filter coefficients is indicative of a substantially null transfer function.

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25 18. A method as defined in claim 17, wherein when the selected set of filter coefficients is indicative of a substantially null transfer function, said method comprises:

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- a) replacing the selected set of filter coefficients by a null set of filter coefficients;
- b) releasing the null set of filter coefficients.

19. A computer readable medium including a program element suitable for execution by a computing apparatus for producing a set of filter coefficients, the set of filter coefficients being suitable for use by an adaptive filter and being indicative of a transfer function of a system in a given state, said computing apparatus comprising:

5 a) a memory unit;

 b) a processor operatively connected to said memory unit, said program element when executing on said processor being operative for:

 i. receiving a sequence of samples of a first signal;

 ii. receiving a sequence of samples of a second signal, the second signal including a certain component which is correlated to the first signal;

10 iii. generating a first set of filter coefficients on the basis of first subsets of the sequences of samples of the first signal and the second signal, the first set of filter coefficients being such that when the first set of filter coefficients is applied by an adaptive filter on the first signal, a first estimate of the certain component in the second signal is generated, the certain component being correlated to the first signal;

15 iv. generating a second set of filter coefficients on the basis of second subsets of the sequences of samples of the first signal and the second signal, at least some samples in the second subsets being subsequent to the samples in corresponding first subsets, the second set of filter coefficients being such that when the second set of filter coefficients is applied by an adaptive filter on the first signal, a second estimate of the certain component in the second signal is generated, the certain component being correlated to the first signal;

20 v. processing the first signal and the second signal on the basis of the first set of filter coefficients to generate a first set of error characterization data elements associated to the first set of filter coefficients;

25 vi. processing the first signal and the second signal on the basis of the second set of filter coefficients to generate a second set of error characterization data elements associated to the second set of filter coefficients;

30 vii. detecting a change of state at least in part of the basis of:

 (a) the first and second sets of filter coefficients; and

 (b) the second set of error characterization data elements;

viii. selecting the second set of filter coefficients when a change of state is detected in vii.;

ix. selecting either one of the first set of filter coefficients and the second set of filter coefficients at least in part on the basis of the first and second sets of error characterization data elements when no change of state is detected in vii.;

5 x. releasing a signal indicative of the selected set of filter coefficients.

20. A computer readable medium as defined in claim 19, wherein:

- a) the first subset of the sequence of samples of the first signal includes a plurality of successive samples, said plurality of successive samples including a beginning sample;
- 10 b) the second subset of the sequence of samples of the first signal includes a plurality of successive samples, said plurality of successive samples including a beginning sample;
- 15 said program element when executing on said processor being further operative for precluding detection of a change of state when the beginning sample of the first subset of the sequence of samples of the first signal is received subsequently to the beginning sample of the second subset of the sequence of samples of the first signal.

20 21. A computer readable medium as defined in claim 20, wherein said program element when executing on said processor is further operative for:

- a) comparing the first set of filter coefficients and the second set of filter coefficients to derive a first distance measure data element;
- b) comparing the first set of error characterization data elements and the second set 25 of error characterization data elements to derive a second distance measure data element;
- c) detecting a change of state, at least in part, on the basis of the first distance measure data element and the second distance measure data element.

30 22. A computer readable medium as defined in claim 21, wherein each error characterization data element in the first and second sets of error characterization data elements is associated to a respective frequency band selected from a set of frequency

bands, said program element when executing on said processor being further operative for:

- 5 a) processing the first set of filter coefficients to derive a first set of spectral values, each spectral value in said first set corresponding to a respective frequency band selected from a set of frequency bands;
- 10 b) processing the second set of filter coefficients to derive a second set of spectral values, each spectral value in said second set corresponding to a respective frequency band selected from a set of frequency bands;
- 15 c) comparing the first set of spectral values to the second set of spectral values to derive a set of first distance measure data elements, each of said first distance measure data elements being associated to a respective frequency band from the set of frequency bands;
- 20 d) comparing the first set of error characterization data elements and the second set of error characterization data elements to derive a set of second distance measure data element, each of said second distance measure data elements being associated to a respective frequency band from the set of frequency bands;
- 25 e) detecting a change of state, at least in part, on the basis of the set of first distance measure data elements and the set of second distance measure data elements.

20 23. A computer readable medium as defined in claim 19, wherein each error characterization data element in the first set of error characterization data elements and in the second set of error characterization data elements is associated to a respective frequency band selected from a set of frequency bands.

25 24. A computer readable medium as defined in claim 23, wherein each error characterization data element in the first and second sets of error characterization data elements includes a standard deviation data element associated to a respective frequency band in the set of frequency bands.

30 25. A computer readable medium as defined in claim 24, wherein said program element when executing on said processor is further operative for:

5 a) computing a first energy data element at least in part on the basis of the first set of error characterization data elements, the first energy data element being indicative of an error size associated to the first set of filter coefficients;

b) computing a second energy data element at least in part on the basis of the second set of error characterization data elements, the second energy data element being indicative of an error size associated to the second set of filter coefficients;

c) selecting the set of filter coefficients on the basis of the first energy data element and the second energy data element when no change of state is detected.

10 26. A computer readable medium as defined in claim 19, wherein said program element when executing on said processor is further operative for processing the selected set of filter coefficients at least in part on the basis of a reference set of data elements prior to releasing the selected set of filter coefficients to determine whether the selected set of filter coefficients is indicative of a substantially null transfer function.

15 27. A computer readable medium as defined in claim 26, wherein when the selected set of filter coefficients is indicative of a substantially null transfer function, said program element when executing on said processor being further operative for:

a) replacing the selected set of filter coefficients by a null set of filter coefficients;

20 b) releasing the null set of filter coefficients.

28. An adaptive system comprising:

a) a first input for receiving a sequence of samples from a first signal;

b) a second input for receiving a sequence of samples of a second signal, the second signal including a certain component which is correlated to the first signal;

25 c) a filter adaptation unit operatively coupled to said first and second inputs, said filter adaptation unit comprising:

i. a coefficient generation unit operative for generating:

30 (a) a first set of filter coefficients on the basis of first subsets of the sequences of samples of the first signal and the second signal, the first set of filter coefficients being such that when the first set of filter coefficients is applied by an adaptive filter on the first signal, a first estimate of the

certain component in the second signal is generated, the certain component being correlated to the first signal;

(b) a second set of filter coefficients on the basis of second subsets of the sequences of samples of the first signal and the second signal, at least some samples in the second subsets being subsequent to the samples in corresponding first subsets, the second set of filter coefficients being such that when the second set of filter coefficients is applied by an adaptive filter on the first signal, a second estimate of the certain component in the second signal is generated, the certain component being correlated to the first signal;

10 ii. an error characterization unit operative for:

(a) processing the first signal and the second signal on the basis of the first set of filter coefficients to generate a first set of error characterization data elements associated to the first set of filter coefficients;

15 (b) processing the first signal and the second signal on the basis of the second set of filter coefficients to generate a second set of error characterization data elements associated to the second set of filter coefficients;

iii. a selection unit operative for:

(a) detecting a change of state, at least in part, on the basis of:

20 (i) the first and second sets of filter coefficients; and

(ii) the second set of error characterization data elements;

(b) selecting the second set of filter coefficients when a change of state is detected in (a);

25 (c) selecting either one of the first set of filter coefficients and the second set of filter coefficients at least in part on the basis of the first and second sets of error characterization data elements when no change of state is detected in (a);

iv. an output for releasing a signal indicative of the set of filter coefficients selected by the selection unit;

30 d) an adaptive filter operatively coupled to said first input and to the output of said filter adaptation unit, said adaptive filter being operative to apply a filtering operation to the first signal on the basis of the set of filter coefficients received

from said filter adaptation unit to generate an estimate of the component in the second signal, the component being correlated to the first signal.

29. An echo cancellor comprising the adaptive system of claim 28.

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30. A filter adaptation unit suitable for producing a set of filter coefficients, said filter adaptation unit comprising:

- a) means for receiving a sequence of samples of a first signal;
- b) means for receiving a sequence of samples of a second signal, the second signal including a certain component which is correlated to the first signal;
- c) means for generating a first set of filter coefficients on the basis of first subsets of the sequences of samples of the first signal and the second signal, the first set of filter coefficients being such that when the first set of filter coefficients is applied by an adaptive filter on the first signal, a first estimate of the certain component in the second signal is generated, the certain component being correlated to the first signal;
- d) means for generating a second set of filter coefficients on the basis of second subsets of the sequences of samples of the first signal and the second signal, at least some samples in the second subsets being subsequent to the samples in corresponding first subsets, the second set of filter coefficients being such that when the second set of filter coefficients is applied by an adaptive filter on the first signal, a second estimate of the certain component in the second signal is generated, the certain component being correlated to the first signal;
- e) means for processing the first signal and the second signal on the basis of the first set of filter coefficients to generate a first set of error characterization data elements associated to the first set of filter coefficients;
- f) means for processing the first signal and the second signal on the basis of the second set of filter coefficients to generate a second set of error characterization data elements associated to the second set of filter coefficients;
- g) means for detecting a change of state at least in part of the basis of:
 - i. the first and second sets of filter coefficients; and
 - ii. the second set of error characterization data elements;

h) means for selecting operative for:

- i. selecting the second set of filter coefficients when a change of state is detected in g);
- ii. selecting either one of the first set of filter coefficients and the second set of filter coefficients at least in part on the basis of the first and second sets of error characterization data elements when no change of state is detected in g);
- i) means for releasing a signal indicative of the selected set of filter coefficients.

31. A filter adaptation unit suitable for producing a set of filter coefficients, said filter adaptation unit comprising:

- a) a first input for receiving a sequence of samples of a first signal;
- b) a second input for receiving a sequence of samples of a second signal, the second signal including a certain component which is correlated to the first signal;
- c) a processing unit operative for generating a plurality of sets of filter coefficients on the basis of the sequences of samples of the first signal and the second signal, each set of filter coefficients in said plurality of sets of filter coefficients being associated to a respective segment of said second signal, each segment of said second signal comprising a subset of samples of the sequence of samples of the second signal;
- d) a selection unit operative for comparing the sets of filter coefficients to one another to select at least one set of filter coefficients from said plurality of sets of filter coefficients;
- e) an output for releasing a signal indicative of the set of filter coefficients selected by the selection unit.

32. A filter adaptation unit as described in claim 31, wherein each set of filter coefficients is associated to a respective impulse response, said selection unit being operative for selecting the at least one set of filter coefficients at least in part on the basis of energy values of the impulse responses associated to the plurality of sets of filter coefficients.

33. A filter adaptation unit as described in claim 32, said filter adaptation unit further comprising an error characterization unit operative for processing the first signal and

the second signal on the basis of the plurality of sets of filter coefficients to generate a plurality of sets of error characterization data elements, each set of error characterization data elements being associated to a respective set of filter coefficients from said plurality of sets of filter coefficients, said selection unit operative for conditioning the energy values of the impulse responses associated to the plurality of sets of filter coefficients at least on part on the basis of said plurality of sets of error characterization data elements.

34. A filter adaptation unit as described in claim 32, wherein said selection unit is
10 operative for conditioning the energy values of the impulse responses associated to
the plurality of sets of filter coefficients at least in part on the basis of energy values
associated to said first signal.

35. A method for producing a set of filter coefficients, said method comprising:

- 15 a) receiving a sequence of samples of a first signal;
- b) receiving a sequence of samples of a second signal, the second signal including a certain component which is correlated to the first signal;
- c) generating a plurality of sets of filter coefficients on the basis of the sequences of samples of the first signal and the second signal, each set of filter coefficients in said plurality of sets of filter coefficients being associated to a respective segment of said second signal, each segment of said second signal comprising a subset of samples of the sequence of samples of the second signal;
- d) comparing the sets of filter coefficients to one another to select at least one set of filter coefficients from said plurality of sets of filter coefficients;
- e) releasing a signal indicative of the set of filter coefficients selected by the selection unit.

36. A method as described in claim 35, wherein each set of filter coefficients is associated to a respective impulse response, said method comprising selecting the at least one set of filter coefficients at least in part on the basis of energy values of the impulse responses associated to the plurality of sets of filter coefficients.

37. A method as described in claim 36, wherein said method further comprises:

- a) processing the first signal and the second signal on the basis of the plurality of sets of filter coefficients to generate a plurality of sets of error characterization data elements, each set of error characterization data elements being associated to a respective set of filter coefficients from said plurality of sets of filter coefficients;
- b) conditioning the energy values of the impulse responses associated to the plurality of sets of filter coefficients, at least in part, on the basis of said plurality of sets of error characterization data elements.

10 38. A method as described in claim 37, wherein said method further comprises conditioning the energy values of the impulse responses associated to the plurality of sets of filter coefficients, at least in part, on the basis of energy values associated to said first signal.

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